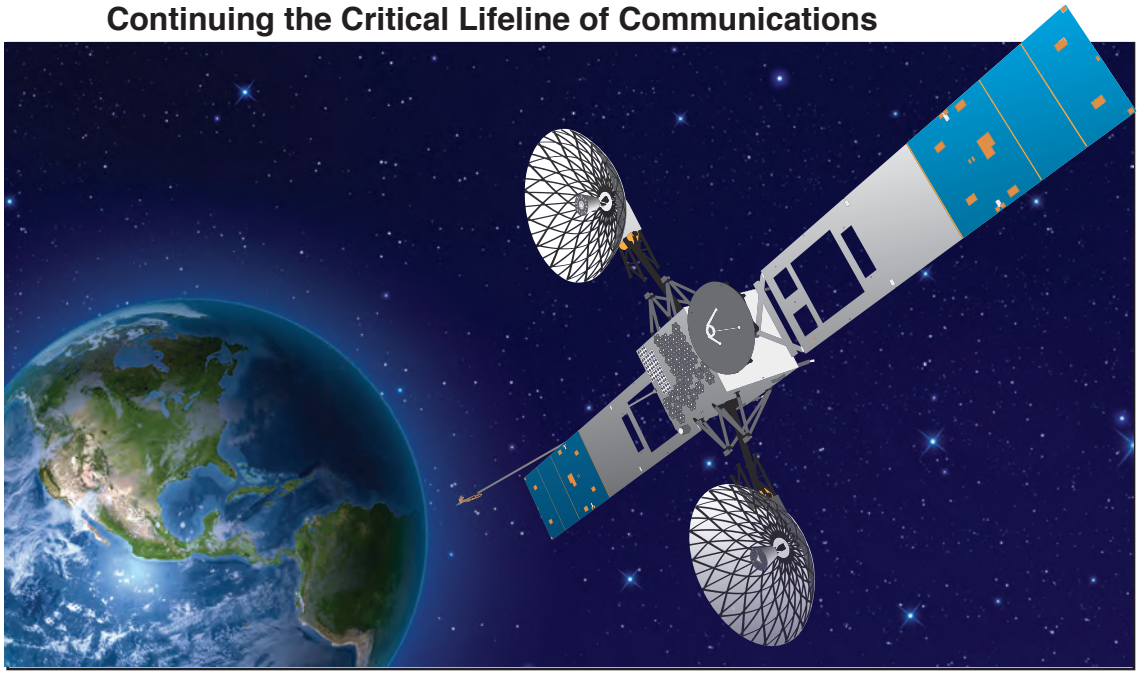
National Aeronautics and Space Administration

NASAfacts

Tracking and Data Relay Satellite: Continuing the Critical Lifeline of Communications



Data is everywhere these days and it powers the world in which we live. Cell phones are a necessity in the business world, automotive microprocessors connected wirelessly to server-based navigation systems help us to find where we are and where we are going, even the elevators shuttling us from floor to floor depend on the transfer of bits of data. Living in the modern world the need for fast, reliable, and accurate communications is critical to keeping the resources that fuel our society running smoothly. Just like people need communications systems to transmit data for everyday items, NASA also needs these systems to send commands to spacecraft, to receive scientific data from satellites, or monitor astronaut health and safety data. Helping to move all those tiny bits of data from spacecraft to ground station and beyond is NASA's Space Network (SN) and the legendary Tracking and Data Relay Satellite (TDRS).

The SN provides an array of global space-to-ground communication services with high performance and reliability. It consists of a constellation of TDRS in geosynchronous orbit that are connected in real-time with a powerful network of ground stations and data processing facilities. While both the development and operations projects are located at the NASA Goddard Space Flight Center in Greenbelt, Md., the TDRS ground segment is comprised of three ground terminals, two in White Sands, New Mexico and another in Guam. Together, they collect data from the TDRS constellation and dispatch it out to a variety of customers.

As a vital information pipeline for space-based research and exploration ambitions, TDRS fulfills NASA's broadest communication demands. Now into its third operational decade, its legacy of communications excellence is storied and grand. It has provided critical support to NASA's human spaceflight endeavors from the early beginning of the Space Shuttle Program through ongoing International Space Station support today. TDRS provides communication support to many different science missions, as well as a number of launch vehicles. The SN provides the ability to conduct real-time operations, for example satellite health monitoring and commanding, and to deliver high volumes of science data with low-latency.

History

The SN was a concept born out of NASA's effort to rely less heavily on international ground stations and create long-duration and highly available communication coverage.The SN is a space-based network made up of geosynchronous communication satellites and three ground terminals. The TDRS project was established in 1973. The prime design goal was to provide continuous, around the clock communications services to NASA's most critical low earth-orbiting missions, and improve the amount of data that could be received.

Using experience gained in the Apollo era and before, NASA began to think differently about its need to move information around the planet. Designed to handle an exponential increase in data volume and provide total coverage for low-Earth-orbiting spacecraft, the program launched TDRS-1 in April of 1983. NASA continued to add first generation TDRS spacecraft (which were built by TRW, later to become Northrop Grumman) until 1995. A total of seven were built and all became operational with the exception of TDRS-2 which was lost aboard Challenger. From 2000-2002, NASA added three new spacecraft to the fleet, thus establishing the second generation. The H, I, and J spacecraft were built by Hughes (later to become Boeing), and continue to operate along with members of the now aging first generation.

TDRS K, L and M missions

With more data moving today than ever before, the communications infrastructure must be able to handle the dual challenges of providing higher data volumes with higher transmission rates. Given that the last of the second generation TDRS was launched a decade ago, NASA is getting ready to deploy a third generation of spacecraft; TDRS K, L, and M, to ensure vital operational continuity.

The TDRS Project is overseeing the build of replacement satellites necessary to maintain and expand the SN. The contract to build the third generation of spacecraft was awarded to Boeing Space Systems in December 2007. This replenishment effort is funded through NASA's Space Communication and Navigation Program, which is part of NASA's Human Exploration and Operations Mission Directorate.

The primary difference between the second and third generation series is the shift from on-orbit beamforming of the S-Band Multiple Access Return services to ground based beamforming (a return from spacecraft onboard beamforming to the first generation architecture).

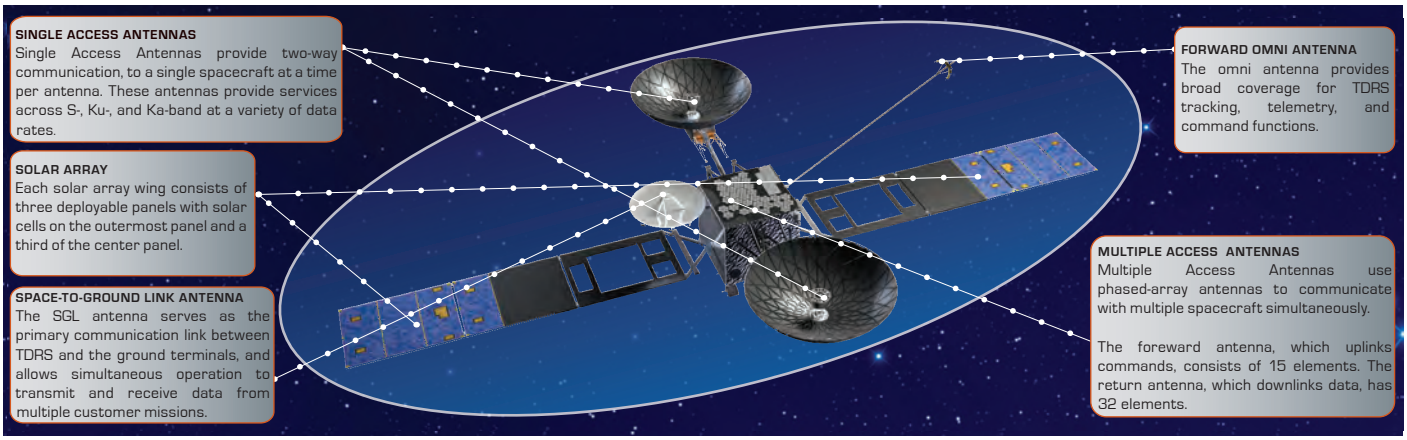
TDRS K is scheduled for launch in 2012 and TDRS L in 2014. TDRS M launch readiness date is scheduled for 2015. The contract also has the option for one additional spacecraft, TDRS N. In addition to building the TDRS K, L, and M spacecraft, the contract also includes modifications to the White Sands Complex (WSC) ground segment, required to support these new spacecraft.

faces of the bus. This modular approach allows development, integration and testing work to proceed in parallel, thereby shortening the manufacturing schedule and test time.

The Payload

Communication satellite payloads are generally comprised of antennas, amplifiers, frequency conversion and connecting communications equipment. The equipment is carefully designed, tested and integrated with the bus to create a functional spacecraft.

The primary payload of each TDRS is the microwave communications equipment and gimbaled antennas. The communications systems of the TDRS spacecraft are designed to provide services to multiple missions simultaneously. Each TDRS has S-band and Ku-band equipment. Second and third generation TDRS also include Ka-band functionality. With the addition of Ka-band capabilities, the TDRS spacecraft dramatically improved their overall service potential by substantially increasing its bandwidth and data rates. TDRS K, L and M will also extend the overall life of the network.



Spacecraft

A constellation of TDRS is always overhead and capable of communicating data, essentially providing an unbroken web for uplinked and downlinked communication. Clearly there are complexities for a system so powerful and sophisticated, but there are a few basic components worth breaking out for explanation.

The TDRS K, L and M satellites have two main components; its unique telecommunications payload, and its bus, the Boeing 601 satellite.

The Bus

Most automated spacecraft are built around a bus. A bus is essentially a chassis in which essential cargo and equipment ride. The bus selected for the second and third generation TDRS is the Boeing 601 satellite, one of the best-selling spacecraft modules in the world.

The Boeing 601 is comprised of two modules, one, the primary structure that carries all launch vehicle loads and contains the propulsion subsystem, bus electronics and battery packs; and, two, a structure of honeycomb shelves that hold communications equipment, electronics and isothermal heat pipes. The evolved version of the 601 bus being used for the K, L, and M missions supports higher performance gallium arsenide solar panels, which are capable of powering a wide variety of services. After 15 years on-orbit, both wings together generate around 3000 Watts of power. Each solar array wing consists of three deployable panels with Ultra Triple Junction cells on the outer-most panel and a third of the center panel.

Antenna reflectors, antenna feeds, and solar arrays mount directly to the payload module, and antenna configurations can be placed on three

Ground Segment Upgrades

The TDRS K, L, and M spacecraft will facilitate years of revitalized, reliable communications and as such the White Sands Complex is getting a functional upgrade to serve the new spacecraft.

This very intense process involves adding modernized Command and Telemetry systems, new generation Ground Based Beamformers (GBBF), two Ka-band end-to-end test antenna systems, and other upgrades associated with the new spacecraft. As this process rolls out, the SN will remain in continuous operation with little to no interruption of service for customers.

TDRS means communications; for international partnerships, research science and telemetry, rescue missions, human spaceflight and more. More data than ever flies through space these days. NASA bustles with activity and promises great adventures in the years ahead. From vital missions studying Earths changing climate, to bold missions looking deep into space with astounding telescopes, to daily research taking place on humanity's brave orbiting outpost the International Space Station. TDRS plays a vital role in keeping it all connected. A wide variety of American interests rely on superb space-based communications, and as a dedicated expert in operations above the atmosphere, NASA regards the TDRS K, L, and M mission as essential not only to the agency, but to the continued understanding of our planet and beyond.

For more detailed information about TDRS K, L and M spacecraft and the existing TDRS fleet, visit:
http://tdrs.gsfc.nasa.gov

For more information, contact Dewayne Washington, Office of Communications, 301-286-0040.

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